

# Polarizing Microscopes



IN its evolutionary period, polarized light microscopy was regarded mainly as a curiosity, of interest to many, but limited in practical use. However, over the years, it was put to work in petrography and allied fields. In more recent years, a wide variety of applications have been developed, until now the polarizing microscope is considered indispensable in many fields including glass and textile manufacture, chemistry, biology, mineralogy, metallurgy, and crystallography.

With the development of these varied uses for the polarizing microscope, a need arose for a diversity of models. Keeping pace with this trend, through the years AO has designed polarizing microscopes keyed to specific tasks. Today, because of this foresight, AO manufacturers the most complete line of polarizing microscopes, 36 models in all.

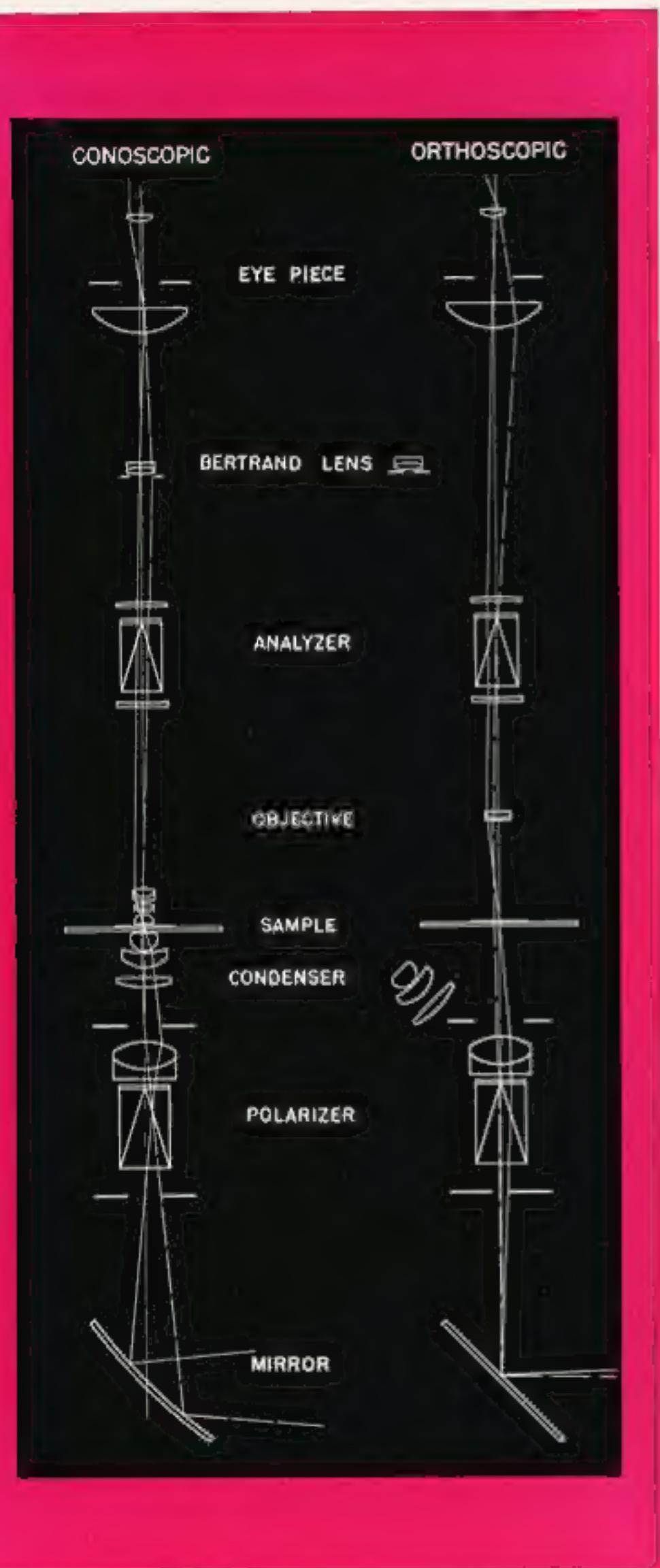
## THE POLARIZING MICROSCOPE

The polarizing microscope is primarily an optical measuring instrument, rather than a medium for the magnification and detailed visual examination of specimens. It is essential in the study and measurement of certain optical properties which have proven difficult or impossible to achieve by other means. Since the polarizing microscope is a measuring instrument, such points as optical centration, the absence of strain in optical components, smooth stage rotation, and the like, assume major importance.

As its name suggests, the polarizing microscope's polarizer and analyzer are its basic components. In early instruments, these elements were composed of natural crystalline materials such as tourmaline and calcite, cut in the form of crystal prisms. The most common forms were the Nicols, the Glans-Thompson, and the Ahrens prisms. Today, the Ahrens prism is probably the most favored because it gives the largest field of view, while calcite has proven to be the most desirable natural crystalline material for this purpose.



INSTRUMENT DIVISION • BUFFALO 15, NEW YORK



### SYNTHETIC POLARIZING FILTERS

By 1946, the development of synthetic polarizing filter materials had progressed to the point where they compared favorably with natural crystal polarizing prisms. AO pioneered in the successful adaptation of this material for use in quality polarizing microscopes. Significant cost reductions have been made possible by its use. The synthetic polarizing filter has been found to resist vapor and fume concentrations of laboratory reagents beyond those which the user is able to tolerate, and is unaffected by temperatures in excess of climatic variations. When the synthetic material is used, the full normal field of the microscope is unimpaired, whereas even the Ahrens prism does offer some restriction. The shorter length of the synthetic analyzer and polarizer and the elimination of several air-glass surfaces also result in a reduction of stray light and an increase in image contrast.

### STRAIN-FREE OPTICS

Optical elements which are placed between the polarizer and analyzer of the polarizing microscope must be free from strain, as far as possible. If this condition is not met, the lens elements themselves produce effects on the light passing through them not unlike a specimen which is "active" in polarized light.

Although all optical elements of AO Spencer Polarizing Microscopes, including objectives, are specially mounted to insure freedom from strain, it should be noted that the term "strain-free" is a relative one. The amount of strain which can be detected is related to the intensity of illumination. In addition, normally strain-free optics can develop strain under extreme temperature conditions, rapid temperature changes, or shock. Care should be taken to avoid such strain-inducing conditions to assure best performance from these components.

### ORTHOSCOPIC AND CONOSCOPIC OBSERVATION

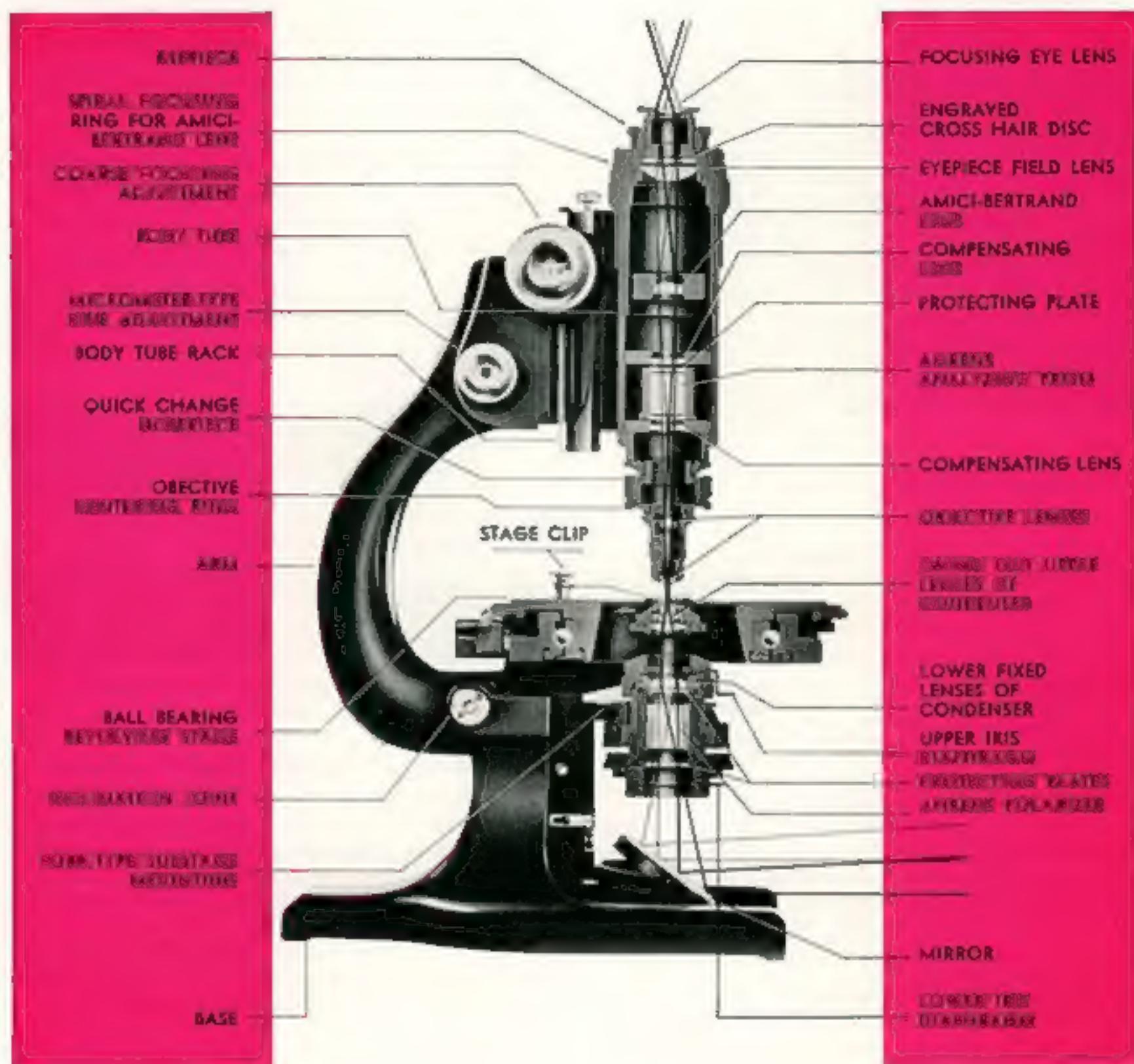
In polarized light microscopy, the instrument is used in two ways. The first is in the observation of the specimen itself and the apparent color of the specimen produced by its effect on polarized light. The colors are referred to as interference colors and the method of observation is known as orthoscopic. For this type of work, the condenser must produce parallel bundles of light. The second type of observation is termed conoscopic and involves the use of a Bertrand lens, or some other technique for studying the light patterns formed by a concentrated, highly convergent beam of light passing through the specimen between crossed polarizer and analyzer. The patterns, seen in the back lens aperture of the objective, are called interference figures.

### MODELS P45 and 44AV

Among the extensive range of AO Polarizing Microscopes there are two, the No. P45 and the No. 44AV, which warrant special mention. The No. P45, AO's lowest cost polarizing microscope, is a simplified type which features an excellent built-in illuminator. It is particularly suitable for educational purposes and laboratory work of a routine



# POLARIZING MICROSCOPES



nature. The No. 44AV, designed for the examination of opaque specimens, is supplied with a vertical illuminator and an attachable illuminating unit. Short mount strain-free objectives are used with this instrument to provide maximum efficiency with reflected light.

## AO OFFERS MANY FEATURES

All models of AO Polarizing Microscopes are available with polarizing filter elements. The more advanced models, Nos. 37, 39, 40, and 41, are also available with calcite prism polarizing elements.

All substage polarizers have complete 360 degree rotation with graduated scale and detent in the zero position. AO provides a specially fitted bearing to achieve this action.

Body tube analyzers are available with either rotatable or non-rotatable mounts on all models.

## CONDENSERS

Because polarizing microscopes must furnish illumination for both orthoscopic and conoscopic observations, the condenser is somewhat different from those used on biological-type microscopes. Convenient change from parallel to convergent light is achieved by a swing-out top condenser unit, with parallel light bundles being obtained when the top unit is out of the optical system.

Condensers are equipped with an iris diaphragm between the lower fixed condensing lens and the top unit. Research microscope models also have a lower iris diaphragm as



Polarizing Microscope condensers. Standard at left; research at right.

standard equipment, while an accessory lower iris is available at additional cost on other models. The function of the iris diaphragms varies with the type of observation employed, and therefore, with the type of illumination obtained from the condenser. For orthoscopic microscopy, with the top condenser out of the system, a lower iris diaphragm acts as a telecentric stop and aids in controlling the parallelism of the bundles of light emerging from the condenser. For conoscopic observation, with the top condenser unit in the system, the upper iris diaphragm serves as a field stop, since it controls the area of the field of view when the Bertrand lens is used. For conventional microscopy, with the top condenser unit in the system, the upper iris diaphragm is a true aperture stop. A simple half-shadow shutter for refractive index studies is built into each condenser.

#### LARGE DIAMETER EYEPieces

Large diameter eyepieces are available on some instruments, while, for reasons of economy, the standard diameter eyepiece tube is offered on others. Adapters are available to permit the use of standard diameter accessories with the large diameter eyepiece tubes. The wider field of view, provided by the large diameter eyepiece, often proves an advantage in polarized light microscopy.

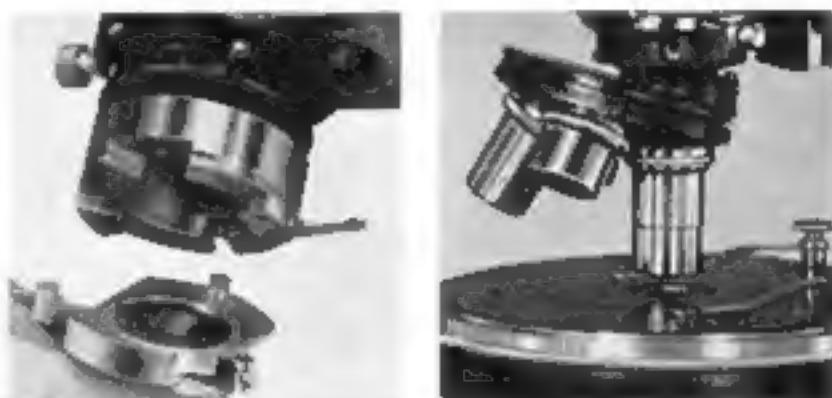
#### ACCOMMODATES UNIVERSAL STAGE

In view of the fact that the Universal Stage is employed by many crystallographers, AO Spencer Polarizing Microscopes, with the exception of No. P45, are drilled and tapped to accept this item. All models will accommodate Universal Stages up to and including the five-axis size, with the exception of the No. P43, which accommodates the three-axis size. A precision plain bearing is used to accomplish smooth stage rotation, except in Microscopes Nos. 37 and 39, both of which employ ball-bearings. A slow motion attachment (factory installation only) is available for use with the latter models.

An intermediate slideway on the body tube adds 50mm to the coarse adjustment excursion, providing ample space for the use of a Universal Stage, vertical illuminator, or a large specimen.

#### QUICK CHANGE AND REVOLVING NOSEPIECES

Most AO Spencer Polarizing Microscopes can be obtained with either quick-change or revolving nosepieces. The quick-change type is recommended for work involving minute particles such as crystal inclusions, where critical centration requirements are imposed on the optical system. For applications involving less exacting work, the lower-priced revolving nosepiece offers greater convenience in changing magnifications.



Left: Quick-change nosepiece and objective centering ring.  
Right: Triple-revolving nosepiece.

#### COMPENSATORS AND QUARTZ WEDGES

Available as accessories, AO Spencer Full Wave and Quarter Wave Compensators of stressed plastic are mounted in metal plates. These are recommended for routine determinations involving optic sign. A Becke aperture plate is offered for use in determining refractive index by the half-shadow or double diaphragm methods.

Popular accessories also include the AO Quartz Wedge, which provides compensation from a true zero order through the third order. It is used to determine optic sign and to estimate retardation.

A graduated quartz wedge, complete with upper analyzer is also available. It provides a means for rapidly measuring retardation without reference to interference color charts.

#### SELECTION OF OPTICAL EQUIPMENT

Listings of all models of AO Spencer Polarizing Microscopes do not include any "standard optical outfit". The diversity of uses for this type of equipment requires that the user have complete freedom of choice in selecting objectives, eyepieces, compensators which suit his needs. Complete optical equipment and accessories for polarizing microscopes will be found in the accessory pages of this section. More general accessories such as illuminators, photomicrographic cameras, camera lucidas, etc. will be found elsewhere.

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A M E R I C A N   O P T I C A L   C O M P A N Y

# POLARIZING MICROSCOPES



No. 555

## No. 555 Graduated Quartz Wedge

The Graduated Quartz Wedge consists of 3 principal parts: a quartz wedge with a scale on the top surface and mounted in a slide; a holder containing a cross-line disc and a Polaroid disc; and a special wide field eyepiece which may be focused on the scale and cross lines. The scale is graduated from -500 to +2500 millimicrons in 10 millimicron intervals. A measuring accuracy of  $\pm 2\%$  is maintained. The lines and numerals are engraved through a semi-transparent metallized surface along the edge of the wedge, and appear bright on a gray field. The Graduated Quartz Wedge fits standard diameter eyepiece tubes without an adapter. Large diameter eyepiece tubes on AO Polarizing Microscopes Nos. 37, 39, 40, and 41 require the No. 551 Universal Adapter.

Cat. No.	Description	Price
555	Graduated Quartz Wedge complete as described above, in case	

## Mechanical Stages

All AO Spencer Polarizing Microscope Stages, except that of the P45, are drilled and tapped to take Mechanical Stages Nos. 495 and 496. They are easily attachable and revolve with the microscope stage. These mechanical stages have a lateral excursion of 75mm and a to-and-fro movement of 25mm. They can be adjusted to accommodate 25 x 75 and 25 x 45mm slides, and are graduated with verniers reading to 0.1mm. Operating buttons are located on each side of the mechanical stage.

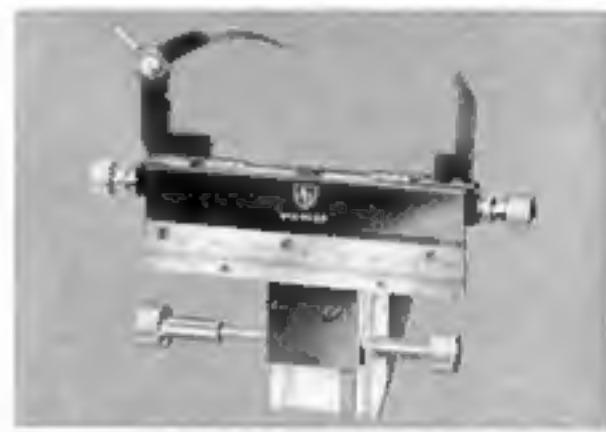
The No. 496 Point Counter Stage (Chayes' Method) is the No. 495 with the addition of click wheels and springs which permit moving the specimen a definite distance with each audible click (0.32mm in the east-west direction or 0.5mm in the north-south direction). The click spring is easily lifted for normal use of the stage.

Cat. No.	Description	Price
495	Graduated Attachable Mechanical Stage for AO Spencer Polarizing Microscopes, in case	
496	Point Counter Mechanical Stage; graduated, attachable to AO Spencer Polarizing Microscopes, in case	

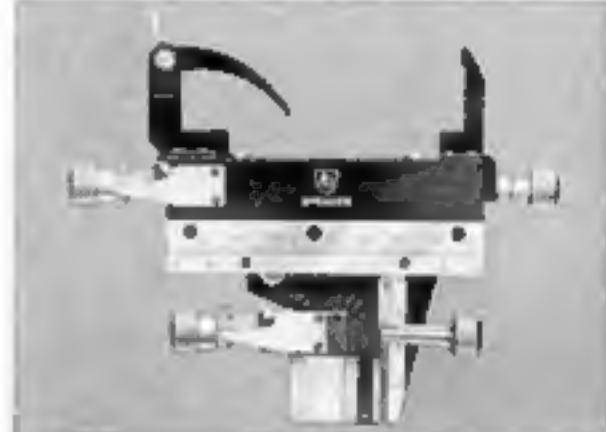


No. 557

No. 495



No. 496



## Slow-Motion Stage Attachment

A slow-motion stage attachment (factory installation only) is available for use with Microscopes Nos. 37 and 39. This attachment is particularly useful for research work in optical crystallography.

Cat. No.	Description	Price
537	Slow-motion attachment for stage, available for use on Microscopes Nos. 37 and 39	

## Top Condenser Unit For Oil Immersion

The N. A. 1.25 Top Condenser Unit No. 534 is recommended for use with oil immersion objectives when the condenser is to be immersed. It replaces the N. A. 1.00 unit supplied as standard on the swing-out condenser arm of Microscopes Nos. 39, 40, 41, P42, and P43.

Cat. No.	Description	Price
534	N.A. 1.25 Top Condenser Unit	

No. 534



**Cabinet**

Sturdy gray leatherette covered carrying case, with handle fastened to lid, holds microscopes in vertical position. A positive draw bolt prevents accidental opening. There is space inside for carrying objectives, eyepieces and compensators.



No. 1280

**Strain-Free Objectives**

Five objectives are recommended for use on the P45 Microscope. All are parfocal on the nosepiece. Choose from the tabular specifications those which best suit your requirements. Either 1287 or 1284 may be used for interference figure observation.

**Cross-Hair Eyepieces**

Cross-hair eyepieces for AO Polarizing Microscopes have a focusing eye lens. The cross-hairs, ruled on a glass reticule disc, are accurately centered with respect to the outside diameter.



No. 449

**For Observing Interference Figures**

For conoscopic observations a pinhole eyepiece is available. For obtaining a magnified image of an interference figure, the telescopic eyepiece may be used in place of a pinhole. Magnification of the Telescopic Eyepiece is 4X.



No. 1000900

**Measuring Accessories**

Micrometer Eyepieces may be used for measuring objects seen through the microscope. Those listed have focusable eye lenses. A stage micrometer is available for calibration.



Scale of No. 415



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Cat. No.	DESCRIPTION				Price	
P45A	Polarizing microscope with double nosepiece in cabinet, but without objectives, eyepiece, or accessories					
P45B	As described above but with triple nosepiece					
P45C	As described above but with quadruple nosepiece					
1647	Cabinet for P45 microscope. If not desired deduct					
388	Replacement bulb 15 watt M.C.P.					

Select Objectives, Eyepieces and Compensators from listing below:

**AO P45 Polarizing Microscope Accessories**

Cat. No.	Eq. Av. Focal In mm	Initial Magnifi- cation	N.A.	Working Distance In mm	Price	
					Un- coated	Ameri- coated
1274	30.2	3.5	.09	24.1		
1275	25	5	.17	21.0		
1280	16	10	.25	4.5		
1284	8	20	.50	1.44		
1287	4	43	.66	0.63		

Cat. No.	DESCRIPTION	Price
447	Cross-Hair Eyepiece, 6X standard size	
448	Cross-Hair Eyepiece, 8X standard size	
449	Cross-Hair Eyepiece, 10X standard size	

546 Pinhole Eyepiece, Standard Diameter  
1000900 Telescopic Eyepiece

Cat. No.	DESCRIPTION	Price
415	Micrometer Eyepiece, 6X, 5mm scale divided into 50 parts	
420	Micrometer Eyepiece, 10X, 5mm scale divided into 100 parts	
400	Stage Micrometer with 2mm scale divided into units of 0.01mm	

**Compensators**

Below are listed accessories for determining the nature of birefringence. These are in metal mounts fitting the slot in the lower end of the body tubes of all AO Spencer Polarizing Microscopes. The mount is marked with an arrow to indicate the direction of the retarded or "slow" ray. The No. 545 includes a Full-Wave Plate as well as the accurately milled apertures.

Cat. No.	DESCRIPTION	Price
540	Full-Wave Plate, 1st order red	
542	Quartz Wedge, I to III order	
544	Quarter-Wave Plate	
545	Becke Aperture Plate	





## POLARIZING MICROSCOPE

Nos. P42 and P43

- For routine work or student use in optical crystallography
- Simplified adjustments
- Moderate price



LEFT—AO Spencer Polarizing Microscope No. P42AC as described.

RIGHT—AO Spencer Polarizing Microscope No. P43AC as described.



## Stand

The stand of both the Nos. P42 and P43 Microscopes measures 103mm from optical axis to arm at stage level, 132mm from table to stage and provides a radial clearance of 78mm from the center of the stage to the coarse adjustment "V" block.

Range of movement in the coarse adjustment (diagonal rack and pinion) is 70mm with an added 50mm excursion permitted by an intermediate dovetail slide. This additional excursion allows ample space for use of a vertical illuminator when desired.

The micrometer-screw type fine adjustment is graduated to show .0025mm of movement.

## Body Tube

Both microscopes offer a large-sized body tube with standard diameter eyepiece tube and pinhole eyepiece. A slot in the body tube for use of optical compensators is provided with a shutter so that it can be closed when not in use.

The analyzer, of optical quality Polaroid, is available in either a rotatable or fixed mount. The letter A or B in the

microscope listing indicates the rotatable or fixed mount.

The P42 Microscope is available with a fixed focus Amici-Bertrand lens which is precentered at the factory and is not equipped with an iris diaphragm. The No. P43 Microscope has no Bertrand lens.

Both microscopes are available with either a quick-change nosepiece with three objective centering rings or a triple-revolving nosepiece, specified by a second letter, C or D, in the microscope listing. When 2 or 4 objectives are ordered with the D outfit, a double or quadruple revolving nosepiece may be specified if desired.

## Stage

The Nos. P42 and P43 Microscopes use the 125mm plain-bearing, revolving stage having the periphery graduated in degrees with a vernier reading to three minutes of arc. When a revolving nosepiece is specified (Nos. P42AD, P42BD, P43AD or P43BD), a centerable stage is supplied. The stage for the Nos. P42 and P43 is drilled and tapped to accommodate the smaller universal stages as well as the No. 495 AO Spencer Mechanical Stage.

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**Substage Equipment**

Both the Nos. P42 and P43 are equipped with a combined condenser and polarizer having a numerical aperture of 1.0. The Polaroid polarizer is mounted in a graduated rotatable mount. The upper condenser element is mounted in a stirrup and can be inserted or removed from the optical system quickly and easily to provide parallel or converging light as desired. An interchangeable upper element of N.A. 1.25 is available as an accessory. The condenser is equipped with an upper iris diaphragm and a simple shutter for work with oblique light. A lower iris diaphragm is available as an accessory.

**Cabinet**

Both microscopes are supplied in attractively finished hard-wood cabinets with lock and key. A felt-lined accessory case is included.



No. 455 AO triple revolving, dual-cone nosepiece  
on No. 42 AD.

*The following comparative listings include three objective centering rings or triple revolving nosepiece, but no objectives, eyepieces, or compensators. See catalog sheet for a complete list of AO Spencer Polarizing Microscope objectives, eyepieces, vertical illuminators and accessories.*

Cat. No.	Bertrand Lens		Analyzer		Nosepiece	Stage	Substage Polarizer	Price
	Focusing Method	Iris Diaphragm	Type	Mount				
P42AC	Fixed	None	Polaroid	Rotatable	Quick-Change with 3 Obj. Centering Rings	Non-centerable	Polaroid	
P42BC	Fixed	None	Polaroid	Non-rotatable	Quick-Change with 3 Obj. Centering Rings	Non-centerable	Polaroid	
P42AD	Fixed	None	Polaroid	Rotatable	Triple Revolving Non-centering	Centerable	Polaroid	
P42BD	Fixed	None	Polaroid	Non-rotatable	Triple Revolving Non-centering	Centerable	Polaroid	
P43AC	None	None	Polaroid	Rotatable	Quick-Change with 3 Obj. Centering Rings	Non-centerable	Polaroid	
P43BC	None	None	Polaroid	Non-rotatable	Quick-Change with 3 Obj. Centering Rings	Non-centerable	Polaroid	
P43AD	None	None	Polaroid	Rotatable	Triple Revolving Non-centering	Centerable	Polaroid	
P43BD	None	None	Polaroid	Non-rotatable	Triple Revolving Non-centering	Centerable	Polaroid	

534 N.A. 1.25 Top Condenser Unit

546 Pinhole Eyepiece (standard diameter, 23.22mm) deductible if not desired

526 Lower Iris Diaphragm

463 Objective Centering Ring (3 furnished with Quick-Change Nosepiece), price for each additional

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A M E R I C A N   O P T I C A L   C O M P A N Y



## POLARIZING MICROSCOPE

No. 41



- For advanced work in optical crystallography
- Complete adjustments
- Choice of natural crystal or Polaroid elements

*AO Spencer Polarizing Microscope  
No. 41AC as described.*

**Stand**

The stand is 103mm from optical axis to arm at stage level, 132mm from table to stage and provides a radial clearance of 78mm from the center of the stage to the coarse adjustment "V" block.

The coarse adjustment (diagonal rack and pinion) provides a vertical movement of 70mm with an added excursion of 50mm permitted by an intermediate dovetail slide. This additional excursion allows ample space for use of a vertical illuminator when desired.

The micrometer-screw type fine adjustment is graduated to show .0025mm of movement.

**Body Tube**

A large-sized body tube with large eyepiece tube and pin-hole eyepiece is included. The body tube has a slot for use of optical compensators and a shutter provides for closing the slot when not in use.

Microscope No. 41 uses a 12mm Ahrens prism analyzer, available in either a fixed or rotatable mount. In the listing on the reverse side, the letter A after the number designates rotatable, the letter B designates fixed mount. Microscope No. P41 uses a Polaroid analyzer in place of the Ahrens analyzer.

The Bertrand lens in vertical focusing sleeve mount is centerable and has a built-in iris diaphragm. A quick-change nosepiece with three objective centering rings or a non-centerable triple revolving nosepiece may be specified. In the comparative listing the second letter (C or D respectively) after the microscope model number indicates the type of nosepiece desired. When 2 or 4 objectives are ordered with Model D, a double or quadruple nosepiece may be specified if desired.

**Stage**

The 123mm plain-bearing, revolving stage has the periphery graduated in degrees with a vernier reading to three minutes of arc. A centerable stage is supplied as standard equipment when the microscope has a revolving nosepiece, as on microscopes Nos. 41AD, 41BD, P41AD, and P41BD. The stage is drilled and tapped to accommodate the smaller universal stages as well as the No. 495 AO Spencer Mechanical Stage.

**Substage Equipment**

Microscope No. 41 is equipped with a combined condenser and polarizer having a numerical aperture of 1.0. The polarizer is a 12mm Ahrens prism mounted in a graduated rotatable mount. The upper condenser element is mounted

in a stirrup and can be inserted and removed from the optical system quickly and easily to provide parallel or converging light as desired. An interchangeable upper element of N.A. 1.25 is available as an accessory. The condenser is equipped with an upper iris diaphragm and a simple shutter for work with oblique light. A lower iris diaphragm is available as an accessory.

The No. P41 substage equipment is identical with the exception of the polarizer which is Polaroid instead of an Ahrens prism.

#### Cabinet

The microscope is supplied in an attractively finished hardwood cabinet with lock and key. A felt-lined accessory case is included with the cabinet.

*The following comparative listings include three objective centering rings or triple revolving nosepiece, but no objectives, eyepieces, or compensators. See catalog sheet for a complete list of AO Spencer Polarizing Microscope objectives, eyepieces, vertical illuminators and accessories.*



*AO Spencer Polarizing Microscope  
No. 41AD as described.*

Cat. No.	Bertrand Lens		Analyzer		Nosepiece	Stage	Substage Polarizer	Price
	Focusing Method	Iris Diaphragm	Type	Mount				
41AC	Vertical Sleeve	Centerable	12mm Ahrens	Rotatable	Quick-Change with 3 Obj. Centering Rings	Non-centerable	12mm Ahrens	
41BC	Vertical Sleeve	Centerable	12mm Ahrens	Non-rotatable	Quick-Change with 3 Obj. Centering Rings	Non-centerable	12mm Ahrens	
41AD	Vertical Sleeve	Centerable	12mm Ahrens	Rotatable	Triple Revolving Non-centering	Centerable	12mm Ahrens	
41BD	Vertical Sleeve	Centerable	12mm Ahrens	Non-rotatable	Triple Revolving Non-centering	Centerable	12mm Ahrens	
P41AC	Vertical Sleeve	Centerable	Polaroid	Rotatable	Quick-Change with 3 Obj. Centering Rings	Non-centerable	Polaroid	
P41BC	Vertical Sleeve	Centerable	Polaroid	Non-rotatable	Quick-Change with 3 Obj. Centering Rings	Non-centerable	Polaroid	
P41AD	Vertical Sleeve	Centerable	Polaroid	Rotatable	Triple Revolving Non-centering	Centerable	Polaroid	
P41BD	Vertical Sleeve	Centerable	Polaroid	Non-rotatable	Triple Revolving Non-centering	Centerable	Polaroid	

534 N. A. 1.25 Top Condenser Unit

547 Pinhole Eyepiece (large diameter, 30.00mm) deductible if not desired

526 Lower Iris Diaphragm

483 Objective Centering Ring (3 furnished with Quick-Change Nosepiece), price for each additional



## POLARIZING MICROSCOPES



### POLARIZING MICROSCOPE

No. 40

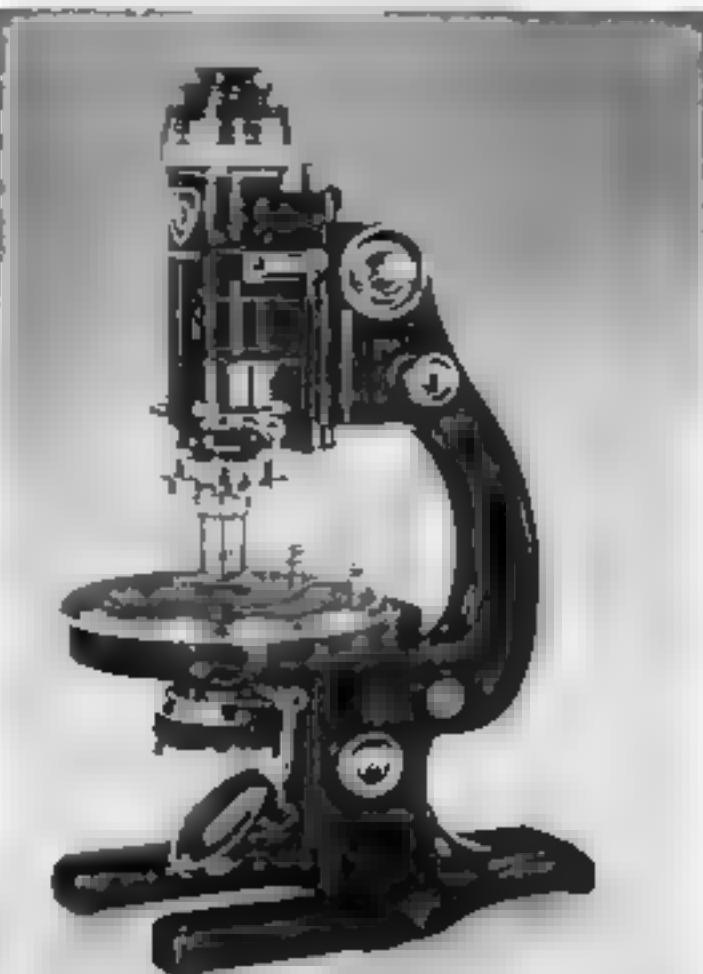
- For advanced routine and research in optical crystallography
- Maximum convenience of adjustments
- Choice of natural crystal or Polaroid elements

#### Stand

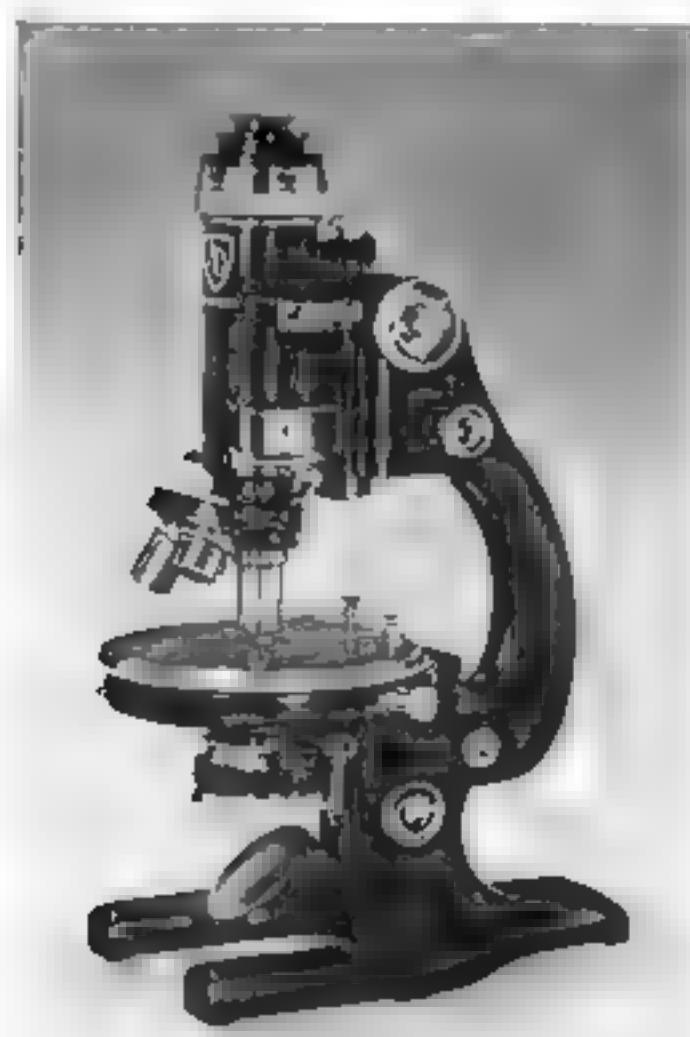
The stand is 103mm from optical axis to arm at stage level, 132mm from table to stage, and provides a radial clearance of 78 mm from the center of the stage to the coarse adjustment "V" block.

The coarse adjustment by diagonal rack and pinion provides a movement of 70mm. An intermediate dovetail slide permits 50 mm additional excursion. This additional excursion allows ample space for use of a vertical illuminator when desired.

The micrometer-screw type fine adjustment is graduated to show .0025mm of movement.



*AO Spencer Polarizing Microscope  
No. 40AC as described*



*AO Spencer Polarizing Microscope  
No. 40AD as described*

#### Body Tube

A large-sized body tube with large eyepiece tube and pin-hole eyepiece is included. The body tube has a slot for use of optical compensators and a shutter provides for closing the slot when not in use.

The 12mm Ahrens analyzer in No. 40 is available in either a rotatable or non-rotatable mount. In the listings on the reverse side, the mounts are designated by the letter A or B respectively following the microscope number. Microscope No. P40 uses a Polaroid analyzer of precision optical quality, in place of the 12mm Ahrens analyzer.

The spiral-focusing Bertrand lens is in a centerable mount with built-in iris diaphragm. A quick-change nosepiece with three objective centering rings or a non-centerable, triple revolving nosepiece may be specified. These nosepieces are indicated by a second letter (either C or D respectively) following the catalog number. When 2 or 4 objectives are ordered with a D model, a double or quadruple revolving nosepiece may be specified if desired.

#### Stage

The 125mm plain-bearing, revolving stage has the periphery graduated in degrees with a vernier reading to three

minutes of arc. On Microscopes Nos. 40AD, 40BD, P40AD, and P40BD a centerable stage is supplied when a revolving nosepiece is specified. The stage is drilled and tapped to accommodate the smaller universal stages as well as the No. 495 AO Spencer Mechanical Stage.

#### Substage Equipment

Microscope No. 40 is equipped with a combined condenser and polarizer having a numerical aperture of 1.0. The polarizer is a 12mm Ahrens prism mounted in a graduated rotatable mount. The upper condenser element is mounted in a stirrup and can be inserted and removed from the optical system quickly and easily to provide parallel or con-

verging light as desired. An interchangeable upper element of N.A. 1.25 is available as an accessory. The condenser is equipped with an upper iris diaphragm and a simple shutter for work with oblique light. A lower iris diaphragm is available as an accessory.

The No. P40 substage equipment is identical with the exception of the polarizer which is Polaroid instead of an Ahrens prism.

#### Cabinet

The microscope is supplied in an attractively finished hard-wood cabinet with lock and key. A felt-lined accessory case is included with the cabinet.

*The following comparative listings include three objective centering rings or triple revolving nosepiece, but no objectives, eyepieces, or compensators. See catalog sheet for a complete list of AO Spencer Polarizing Microscope objectives, eyepieces, vertical illuminators and accessories.*

Cat. No.	Bertrand Lens		Analyzer		Nosepiece	Stage	Substage Polarizer	Price
	Focusing Method	Iris Diaphragm	Type	Mount				
40AC	Spiral	Centerable	12mm Ahrens	Rotatable	Quick-Change with 3 Obj. Centering Rings	Non-centerable	12mm Ahrens	
40BC	Spiral	Centerable	12mm Ahrens	Non-rotatable	Quick-Change with 3 Obj. Centering Rings	Non-centerable	12mm Ahrens	
40AD	Spiral	Centerable	12mm Ahrens	Rotatable	Triple Revolving Non-centering	Centerable	12mm Ahrens	
40BD	Spiral	Centerable	12mm Ahrens	Non-rotatable	Triple Revolving Non-centering	Centerable	12mm Ahrens	
P40AC	Spiral	Centerable	Polaroid	Rotatable	Quick-Change with 3 Obj. Centering Rings	Non-centerable	Polaroid	
P40BC	Spiral	Centerable	Polaroid	Non-rotatable	Quick-Change with 3 Obj. Centering Rings	Non-centerable	Polaroid	
P40AD	Spiral	Centerable	Polaroid	Rotatable	Triple Revolving Non-centering	Centerable	Polaroid	
P40BD	Spiral	Centerable	Polaroid	Non-rotatable	Triple Revolving Non-centering	Centerable	Polaroid	

534 N.A. 1.25 Top Condenser Unit

547 Pinhole Eyepiece (large diameter, 30.00mm) deducible if not desired

526 Lower Iris Diaphragm

463 Objective Centering Ring (3 furnished with Quick-Change Nosepiece), price for each additional

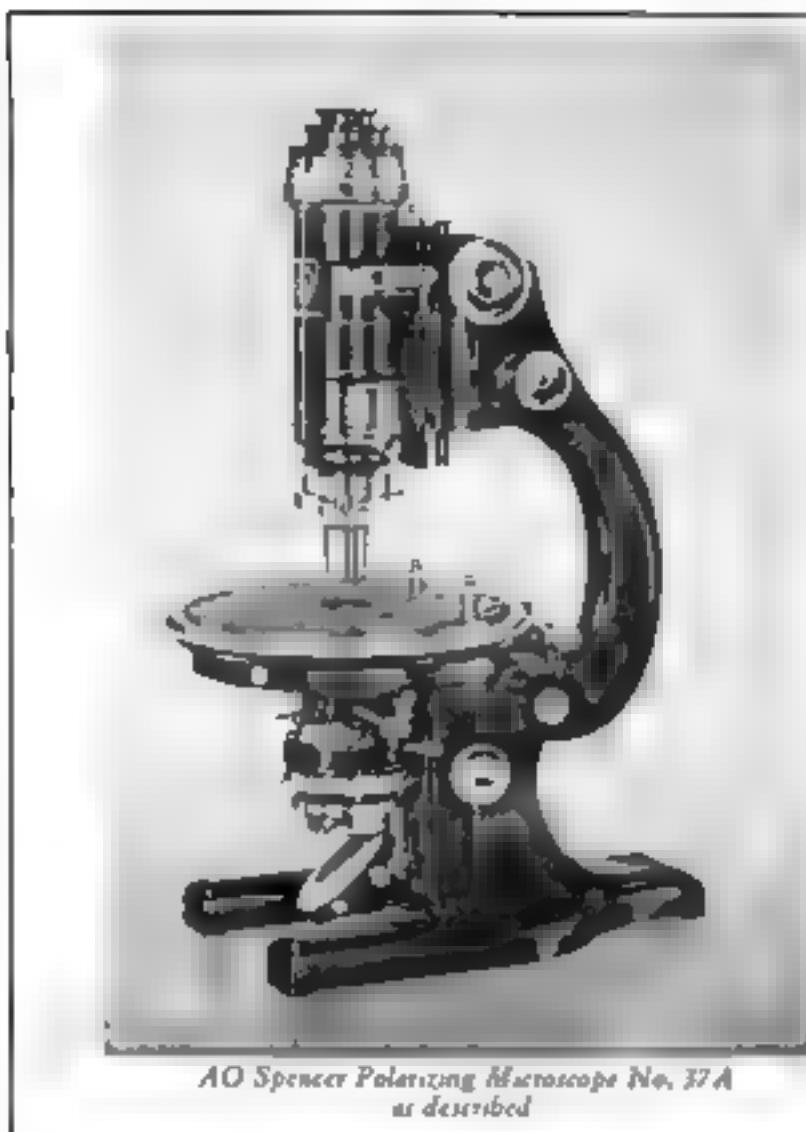
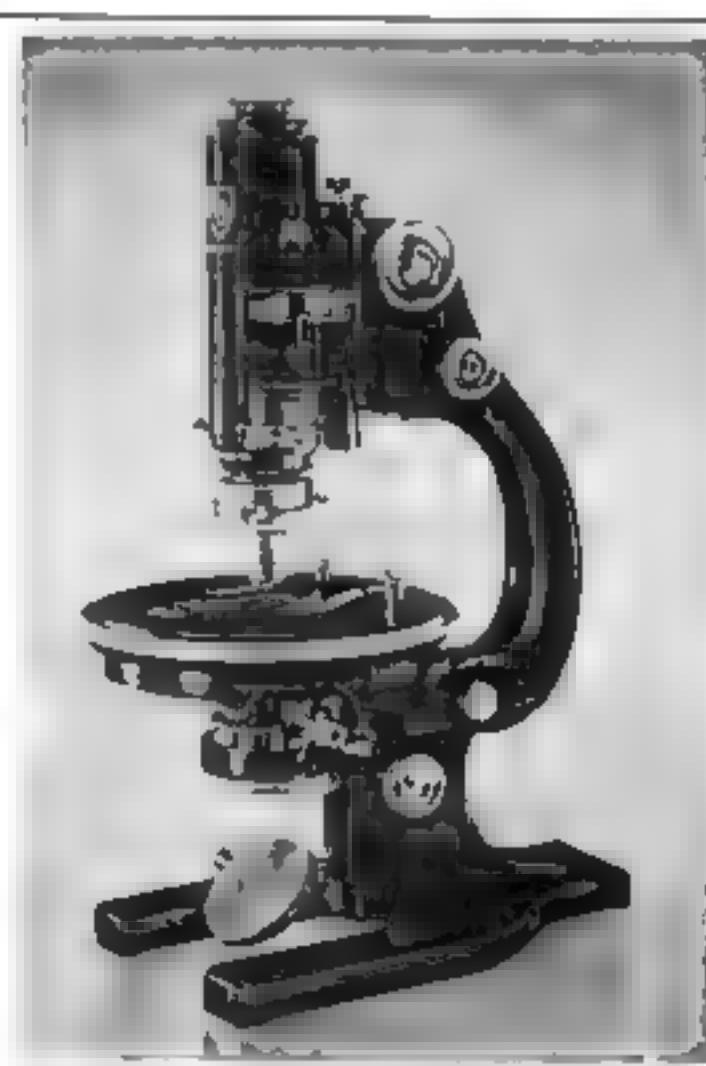




## POLARIZING MICROSCOPE

Nos. 37 and 39

- For research in optical crystallography
- Maximum adaptability and precision
- 150mm ball-bearing revolving stage

AO Spencer Polarizing Microscope No. 37A  
as describedAO Spencer Polarizing Microscope No. 39A  
as described**Stand**

Both microscopes have the same stand and stage. The stand is large, 116mm from optical axis to arm at stage level, 170mm from table to stage, and provides a radial clearance of 85mm from the center of the stage to the coarse adjustment "V" block.

The coarse adjustment (diagonal rack and pinion) provides a movement of 80mm. An intermediate dovetail slide extends the excursion a further 50mm, providing ample extension for use of a vertical illuminator.

The micrometer-screw type fine adjustment is graduated to show .001 mm of movement.

**Body Tube**

Both microscopes have a large-sized body tube with large diameter eyepiece tube and pulchre eyepiece. A properly oriented slot for the introduction of compensators is provided with a shutter so that it can be closed when not in use. The analyzer, a 12mm Ahrens prism in the No. 37 and No. 39, is available on either a rotatable or fixed mount, designated

# A O S C I E N T I F I C I N S T R U M E N T S

in the listings below by the letter A or B respectively after the microscope number. Nos. P37 and P39, lower in price, have Polaroid analyzers in place of the 12mm Ahrens prisms.

The No. 37 has a spiral-focusing Bertrand lens whereas the No. 39 uses a Bertrand lens in vertical-focusing sleeve mount. Regardless of the difference in focusing mechanism, the Bertrand lens is centerable and is provided with an iris diaphragm. A quick-change nosepiece with three objective centering rings is standard equipment.

## Stage

Both microscopes have the 150mm ball-bearing revolving stage. The periphery is graduated in degrees with a vernier reading to three minutes of arc. A slow-motion stage adjustment is available at slight additional cost; this mechanism can be installed only at the factory. The stages are drilled and tapped to take a 3, 4, or 5 axis universal stage or the No. 495 AO Spencer Mechanical Stage.

## Substage Equipment

The combined condensers and polarizers for all AO Spencer Polarizing Microscopes are equipped with a stirrup mounting for the upper condenser elements so that they

may be thrown in or out of the optical system to change from parallel to converging light quickly and easily. A convenient shutter for oblique light work is also provided.

Microscope No. 37 has the large, 5-element, achromatic substage condenser, complete with 15mm Ahrens prism polarizer in graduated rotatable mount with upper and lower iris diaphragms. The No. P37 has an identical substage except that Polaroid is used in place of the Ahrens prism. These condensers have interchangeable front elements providing N.A. 1.40 and N.A. 1.0.

Microscope No. 39 is supplied with the 3-element combined substage condenser with 12mm Ahrens prism polarizer in graduated rotatable mount. The No. P39 has an identical substage except that Polaroid is used instead of the Ahrens prism. These condensers have a numerical aperture of 1.0. An N.A. 1.25 top element is available as an accessory. The upper iris diaphragm is standard equipment on the No. 39 and No. P39. A lower iris diaphragm is available also as an accessory.

## Cabinet

These microscopes are supplied in attractively finished hardwood cabinets complete with lock and key. A felt-lined accessory case is included.

*The following comparative listings include three objective centering rings or triple revolving nosepiece, but no objectives, eyepieces, or compensators. See catalog sheet for a complete list of AO Spencer Polarizing Microscope objectives, eyepieces, vertical illuminators and accessories.*

Cat. No.	Bertrand Lens		Analyzer		Nose- piece	Stage*	Substage Equipment			Price
	Focusing Method	Iris Diaphragm	Type	Mount			Polarizer	Lower Iris	Condenser	
37A	Spiral	Centerable	12mm Ahrens	Rotatable	Quick- Change	Non- centerable	12mm Ahrens	Furnished	3-element	N.A. 1.00 and N.A. 1.40
37B	Spiral	Centerable	12mm Ahrens	Non- rotatable	Quick- Change	Non- centerable	12mm Ahrens	Furnished	3-element	N.A. 1.00 and N.A. 1.40
P37A	Spiral	Centerable	Polaroid	Rotatable	Quick- Change	Non- centerable	Polaroid	Furnished	3-element	N.A. 1.00 and N.A. 1.40
P37B	Spiral	Centerable	Polaroid	Non- rotatable	Quick- Change	Non- centerable	Polaroid	Furnished	3-element	N.A. 1.00 and N.A. 1.40
39A	Vertical Sleeve	Centerable	12mm Ahrens	Rotatable	Quick- Change	Non- centerable	12mm Ahrens	Available**	3-element	N.A. 1.00***
39B	Vertical Sleeve	Centerable	12mm Ahrens	Non- rotatable	Quick- Change	Non- centerable	12mm Ahrens	Available**	3-element	N.A. 1.00***
P39A	Vertical Sleeve	Centerable	Polaroid	Rotatable	Quick- Change	Non- centerable	Polaroid	Available**	3-element	N.A. 1.00***
P39B	Vertical Sleeve	Centerable	Polaroid	Non- rotatable	Quick- Change	Non- centerable	Polaroid	Available**	3-element	N.A. 1.00***

\*537 Slow-motion attachment for stage is available for use on Nos. 37 and 39 Microscopes. Additional price

\*\*526 Lower Iris is available for use on No. 39 Microscope. Additional price

\*\*\*534 N.A. 1.25 Top Condenser Unit is also available for use on No. 39 Microscopes. Additional price

547 Pinhole Eyepiece (large diameter, 30.00mm) deductible if not desired

463 Objective Centering Ring (3 furnished with Quick-Change Nosepiece), price for each additional



A M E R I C A N O P T I C A L C O M P A N Y

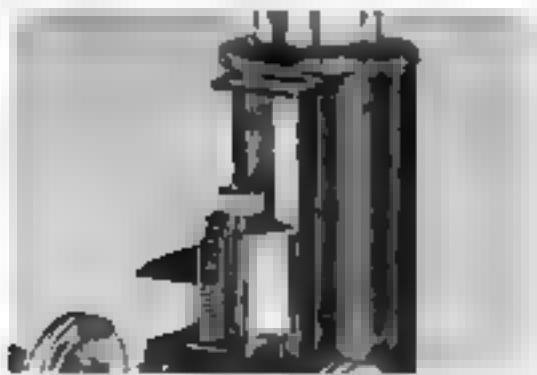


## POLARIZING MICROSCOPE

No. 44AV

**FOR REFLECTED LIGHT**

- Specifically designed for examination of opaque anisotropic materials
- Integral light source of high intensity
- Intermediate slide allows ample working distance



*Intermediate dovetail body tube slide extends the range of the rack-and-pinion adjustment. Focuseable stage is unnecessary.*



*Polarizing Microscope No. 44AV for reflected light, showing Vertical Illuminator with Large Illuminating Unit in place.*

The No. 44AV Polarizing Microscope is designed for the examination of opaque anisotropic material with reflected light. It is particularly useful in the fields of mineralogy and metallurgy. The vertical illuminator with large integral illuminating unit, has adequate intensity for polarized light.

This large size vertical illuminating unit is attached directly to the microscope body on the No. 44AV, AO Polarizing Microscope. As the vertical illuminator is to the left of the microscope all controls are naturally placed and easy to reach. The quick-change nosepiece is mounted on the vertical illuminator. When refocusing to accommodate various specimens the light source is always in perfect optical alignment and is not disturbed.

**Stand**

The stand of the No. 44AV Microscope measures 103mm from optical axis to arm at stage level, 132mm from table to stage and provides a radial clearance of 78mm from the center of the stage to the coarse adjustment "V" block.

Range of movement in the coarse adjustment (diagonal rack and pinion) is 70mm with an added 50mm excursion permitted by an intermediate dovetail slide. This additional excursion allows ample space for use of a vertical illuminator when desired.

The micrometer-screw type fine adjustment is graduated to show .0025mm of movement.

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**Body Tube**

The microscope has a large-sized body tube with standard diameter eyepiece tube. A slot in the body tube for use of optical compensators is provided with a shutter so that it can be closed when not in use. The analyzer, of optical quality Polaroid, is available in a rotatable mount only.

**Stage**

The No. 44AV Microscope uses the 125mm plain-bearing, centerable revolving stage having a periphery graduated in degrees with a vernier reading to three minutes of arc.

**Cabinet**

The No. 44AV Microscope is supplied in an attractively finished hardwood cabinet with lock and key. A felt-lined accessory case is included.

Cat. No.	Description	Price
44AV	AO Spencer Polarizing Microscope for reflected light with vertical illuminator, large illuminating unit, variable transformer, and one objective adapter, but without objectives and eyepieces, in leatherette covered hardwood cabinet	

**Accessories For No. 44AV Microscope**

Short mount, strain-free, achromatic objectives are recommended for optimum performance with polarized vertical illumination. The five objectives in the series have air glass

surfaces coated with Americote, a low-reflecting film that reduces reflections and provides added contrast. They have been corrected for use without a cover glass.

ACHROMATIC OBJECTIVES Americanized, Short Mount, Strain Free					EYEPICES Standard Diameter, Focusing Eye Lenses						
Cat. No.	Equiv. Focus	Magnifi- cation	Numerical Aperture	Price	Cat. No.	Mag.	Type	Scale	Divisions	Price	
C1272	32mm	4X	.10		447	6X	Cross Hair				
C1273	16mm	10X	.25		448	8X	Cross Hair				
C1282	8mm	20X	.30		449	10X	Cross Hair				
C1288	4mm	40X	.85		415	6X	Micrometer	3mm	50 parts		
C1293	1.8mm	95X (oil)	1.25		420	10X	Micrometer	3mm	100 parts		

**2510 Objective Adapter**

(One is supplied as standard with No. 44AV. For convenience, the purchase of an adapter for each additional objective to be used is recommended.)

**Miscellaneous Accessories**

- |   |     |                                    |
|---|-----|------------------------------------|
| 360 Lamp, 6.5-volt, 2.75-amperes                              | MCP | 540 Full-Wave Plate, 1st order red |
| 400 Stage Micrometer (2mm scale divided into units of 0.01mm) |     | 542 Quartz Wedge, 1-3 order        |
| 495 Mechanical Stage, in case                                 |     | 544 Quarter-Wave Plate             |
|   |     | 546 Pinhole Eyepiece               |





## POLARIZING MICROSCOPE ACCESSORIES

BECAUSE of the many dissimilar uses for polarizing microscopes, from the user's point of view it is impractical to furnish standard optical outfits for them. The following listing of objectives, eyepieces, and accessories will allow the purchaser to choose as few or as many as may be required for any type of work. The total price of any polarizing

microscope outfit can be computed by adding the prices of optics and accessories to the price of the microscope stand.

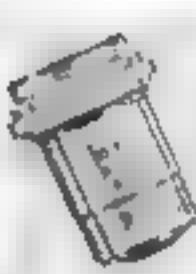
The simplified mechanical construction of the P45 Polarizing Microscope Series does not permit the use of some of the items listed here. Accessories recommended for use with this series are listed on page F6 of the Polarizing Microscope Catalog.

## "Achromatic Strain-Free Objectives (For Transmitted Light)

\*The strain-free objectives listed below are for use with transmitted light only. For work with reflected light see description of short-mount objectives appearing on page F22 of this catalog.



No. 463



No. 1280



No. 1291

All AO Spencer achromatic strain-free objectives for transmitted light are marked with the numerical aperture and initial magnification. They are corrected for a tube length of 166.4mm and for a cover glass thickness of 0.18mm.

For work at low magnification several objectives are offered. Maximum working distance and width of field at low cost characterize Objectives Nos. 1270, 1271, and 1272. Objectives Nos. 1274 and 1275 have a higher numerical aperture and superior optical correction, in addition to the convenience of being parfocal with the higher power objectives listed in the accompanying table.

Two 4mm objectives are offered. Objective No. 1287 has a numerical aperture of 0.66 and a relatively long working distance. It is recommended for orthoscopic work and for conoscopic observations by students where safety of slides and objectives is a factor. The No. 1290 is preferable for conoscopic observations because of its higher numerical aperture of 0.85.

Cat. No.	Equiv. Focus in mm	Initial Magnifi- cation	N.A.	Working Distance in mm	Price	
					Un- coated	Amer- coated**
Dry						
1270	48	2	.08	52.5		
1271	40	3	.08	35.2		
1272	32	4	.10	21.0		
1274	30.2	3.5	.09	24.1		
1275	25	5	.17	21.0		
1280*	16	10	.25	4.5		
1284	8	20	.30	1.44		
1287	4	43	.66	0.63		
1290	4	43	.85	0.17		
1291	3	57	.85	0.20		
Oil Immersion						
1293	1.8	97	1.23	0.11		

\*This objective is separable. When the front system is removed, the back system becomes a 32mm, 4X.

\*\*In ordering American objectives, prefix catalog number with "C", viz C1280.

AO Spencer Polarizing Microscopes featuring quick-change nosepieces have three No. 463 Objective Centering Rings as part of their standard equipment. If more than three objectives are ordered, an additional ring should be purchased for each additional objective.

Cat. No.	Description	Price
463	Objective Centering Ring	

## Cross-Hair Eyepieces



No. 449



No. 451

Cross-hair eyepieces for AO Spencer Polarizing Microscopes have focusing eye lenses. The lines ruled on the glass reticule disc are accurately centered with respect to the outside diameter. Large diameter eyepieces (30mm) are for use with Microscopes Nos. 37, 39, 40, and 41, which have large diameter eyepiece tubes. Standard diameter

Cat. No.	Description	Price
For Microscopes Nos. P42, P43, and 44		
447	Cross-Hair Eyepiece, 6X standard size	
448	Cross-Hair Eyepiece, 8X standard size	
449	Cross-Hair Eyepiece, 10X standard size	
For Microscopes Nos. 37, 39, 40, and 41		
451	Cross-Hair Eyepiece, 5X large size	
453	Cross-Hair Eyepiece, 8X large size	
454	Cross-Hair Eyepiece, 10X large size	
456	Cross-Hair Eyepiece, 15X large size	
457	Cross-Hair Eyepiece, 20X large size	

eyepieces (23.22mm) are for use with Microscopes Nos. P42, P43, and 44, which have standard diameter eyepiece tubes.

Adapters which allow standard diameter eyepieces to be used in large diameter eyepiece tubes are listed in a succeeding appropriately headed table.

#### Pinhole Eyepieces

A pinhole eyepiece, of appropriate diameter size, is supplied as part of the standard equipment of the polarizing microscope stand, except that of the No. 44. Standard diameter (23.22mm) Pinhole Eyepiece No. 546 is used with Polarizing Microscopes Nos. P42, P43, and 44, while No. 547, a pinhole eyepiece of large diameter (30mm) is used with Polarizing Microscopes Nos. 37, 39, 40, and 41.

#### Measuring Accessories



No. 420

Micrometer Eyepieces Nos. 415 and 420, of standard diameter, are available for use on polarizing microscopes. They have focusable eye lenses and fit Polarizing Microscopes Nos. P42, P43, and 44 without an adapter. An eyepiece tube adapter is necessary when using the micrometer eyepieces with AO Microscopes Nos. 37, 39, 40, and 41.

The No. 425 Screw Micrometer Eyepiece is used for precise linear measurements. Instead of visual cross-hairs, it has a finely ruled glass scale with a center "V" reference point. Each scale interval exactly equals one revolution of the screw which moves it. When used on AO Microscopes Nos. 37, 39, 40, and 41, this eyepiece requires the No. 551 Universal Adapter.

A stage micrometer is available for calibrating eyepiece micrometers. For other measuring accessories see catalog sheet D8.

Cat. No.	Description	Price
415	Micrometer Eyepiece, 6X, 3mm scale divided into 50 parts	
420	Micrometer Eyepiece, 10X, 3mm scale divided into 100 parts	
425	Screw Micrometer Eyepiece, 10X, 6mm scale divided into 30 parts, rotating drum divided into 100 parts, in case	
490	Stage Micrometer with 2mm scale divided into units of .01mm	

#### Eyepiece Tube Adapters



No. 550

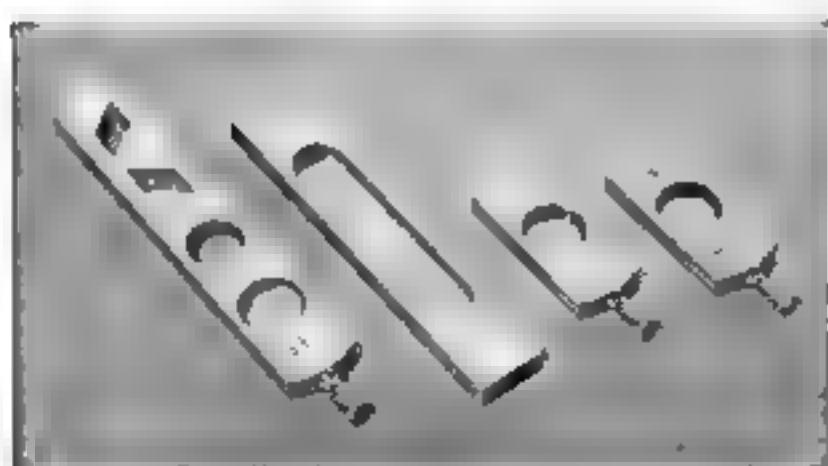


No. 551

Eyepiece Tube Adapters Nos. 550 and 551 are used to adapt large diameter eyepiece tubes to standard diameter size. The 550 adapter is used only for accessories (primarily eyepieces) which drop into the standard diameter eyepiece tube. The No. 551 adapter, referred to as the Universal Adapter, is used either for accessories which drop into, or for accessories which are clamped onto, the standard eyepiece tube. Examples of the latter type of accessory are the No. 545 Graduated Quartz Wedge and the No. 425 Screw Micrometer Eyepiece. The No. 551 Universal Adapter increases the microscope body tube length by about 10mm.

Cat. No.	Description	Price
550	Eyepiece Tube Adapter, large to standard	
551	Universal Eyepiece Tube Adapter, large to standard	

#### Compensators



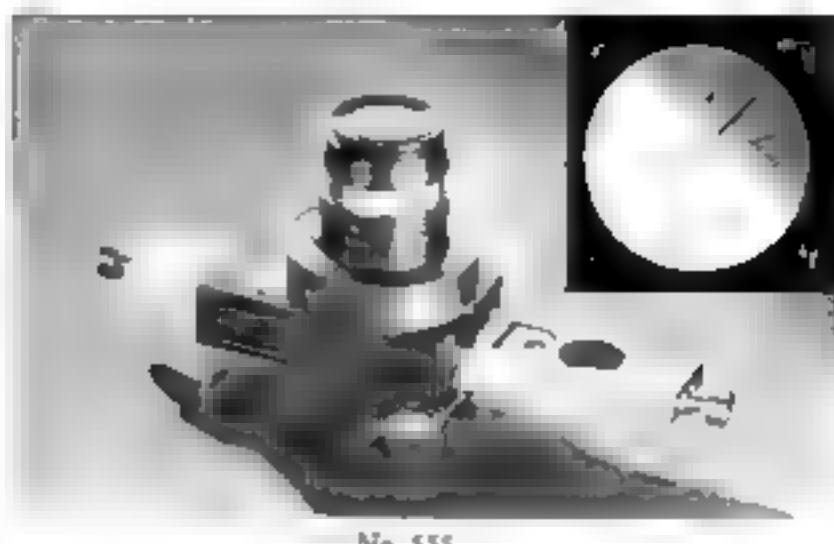
Nos. 545, 542, 544, 540

Below are listed accessories for determining the nature of birefringence. The compensators are supplied in metal mounts which fit into the slot in the lower end of the body tubes of all AO Spencer Polarizing Microscopes. Each mount is marked with an arrow to indicate the direction of the retarded or "slow" ray. No. 545 includes a Full-Wave Plate in addition to the accurately milled apertures.

Cat. No.	Description	Price
540	Full-Wave Plate, 1st order red	
542	Quartz Wedge, I to III order	
544	Quarter-Wave Plate	
545	Becke Aperture Plate	



# POLARIZING MICROSCOPES



No. 555

Cat. No.	Description	Price
555	Graduated Quartz Wedge complete as described above, in case	

## Mechanical Stages

All AO Spencer Polarizing Microscope Stages, except that of the P45, are drilled and tapped to take Mechanical Stages Nos. 495 and 496. They are easily attachable and revolve with the microscope stage. These mechanical stages have a lateral excursion of 73mm and a to-and-fro movement of 25mm. They can be adjusted to accommodate 23 x 75 and 25 x 45mm slides, and are graduated with verniers reading to 0.1mm. Operating buttons are located on each side of the mechanical stage.

The No. 496 Point Counter Stage (Chayes' Method) is the No. 495 with the addition of click wheels and springs which permit moving the specimen a definite distance with each audible click (0.32mm in the east-west direction or 0.5mm in the north-south direction). The click spring is easily lifted for normal use of the stage.

Cat. No.	Description	Price
495	Graduated Attachable Mechanical Stage for AO Spencer Polarizing Microscopes, in case	
496	Point Counter Mechanical Stage graduated, attachable to AO Spencer Polarizing Microscopes, in case	



No. 557

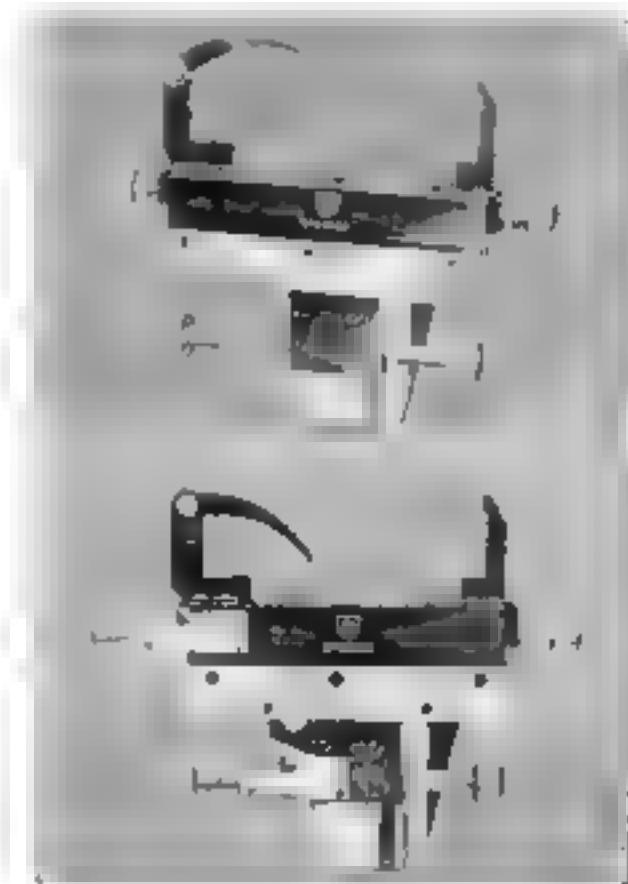
## Top Condenser Unit For Oil Immersion

The N. A. 1.25 Top Condenser Unit No. 534 is recommended for use with oil immersion objectives when the condenser is to be immersed. It replaces the N. A. 1.00 unit supplied as standard on the swing-out condenser arms of Microscopes Nos. 39, 40, 41, P42, and P43.

Cat. No.	Description	Price
504	N.A. 1.25 Top Condenser Unit	

## No. 555 Graduated Quartz Wedge

The Graduated Quartz Wedge consists of 3 principal parts: a quartz wedge with a scale on the top surface and mounted in a slide; a holder containing a cross-line disc and a Polaroid disc; and a special wide field eyepiece which may be focused on the scale and cross lines. The scale is graduated from -500 to +2500 millimicrons in 10 millimicron intervals. A measuring accuracy of  $\pm 2\%$  is maintained. The lines and numerals are engraved through a semi-transparent metallized surface along the edge of the wedge, and appear bright on a gray field. The Graduated Quartz Wedge fits standard diameter eyepiece tubes without an adapter. Large diameter eyepiece tubes on AO Polarizing Microscopes Nos. 37, 39, 40, and 41 require the No. 551 Universal Adapter.



No. 495

No. 496

## Slow-Motion Stage Attachment

A slow-motion stage attachment (factory installation only) is available for use with Microscopes Nos. 37 and 39. This attachment is particularly useful for research work in optical crystallography.

Cat. No.	Description	Price
537	Slow-motion attachment for stage, available for use on Microscopes Nos. 37 and 39	



No. 534



No. 526

**Lower Iris Diaphragm**

A lower iris diaphragm for additional illumination control is available for use on Microscopes Nos. 39, 40, 41, P42, and P43.

Cat. No.	Description	Price
526	Lower Iris Diaphragm	

**Revolving Nosepieces**

Polarizing microscopes which are supplied with the AO Spencer dual-cone revolving nosepieces are equipped to accommodate three objectives unless otherwise specified. When other than a triple nosepiece is desired, indicate the correct nosepiece by catalog number. The price of the triple nosepiece is included in the price of Polarizing Microscope stands where D is the final character in the catalog designation (i.e. P43AD). An appropriate adjustment in the price of the stand must be made when the double or quadruple nosepiece is specified.

Cat. No.	Description	Price
450	Double Revolving Nosepiece (non-centerable)	
453	Triple Revolving Nosepiece (non-centerable)	
440	Quadruple Revolving Nosepiece (non-centerable)	

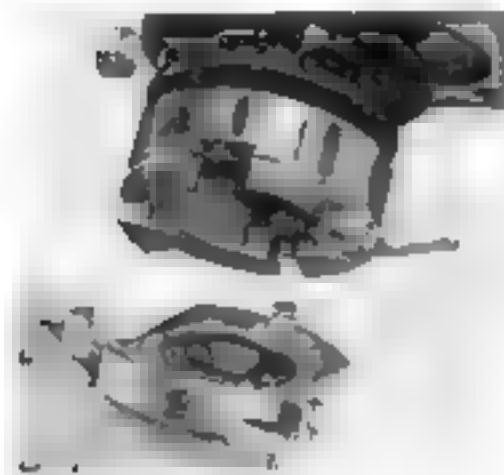


No. 451

**Quick-Change Nosepiece**

AO Spencer Quick-Change Nosepiece No. 462 permits rapid interchange of any number of standard objectives. This nosepiece, used with No. 463 Objective Centering Rings, permits each objective to be individually centered to the optical axis of the microscope. All AO Spencer Polarizing Microscopes equipped with a quick-change nosepiece have three No. 463 Objective Centering Rings supplied as standard equipment. If more than 3 objectives are ordered, an additional centering ring should be purchased for each additional objective.

Cat. No.	Description	Price
462	Quick-Change Nosepiece	
463	Objective Centering Ring	



No. 462 and No. 463

**Polarizing Microscope Cabinet**

AO Polarizing Microscopes are supplied as standard in attractively finished hardwood cabinets, complete with handle, lock and key. Cabinets accommodate a separate velvet-lined accessory case used as a drawer, also furnished as part of the standard equipment. When ordering cabinet separately, specify microscope serial number.

Cat. No.	Description	Price
1640	Cabinet for Microscopes Nos. 40, 41, P42, P43 and 44	
1637	Cabinet for Microscopes Nos. 37 and 39	



No. 1640



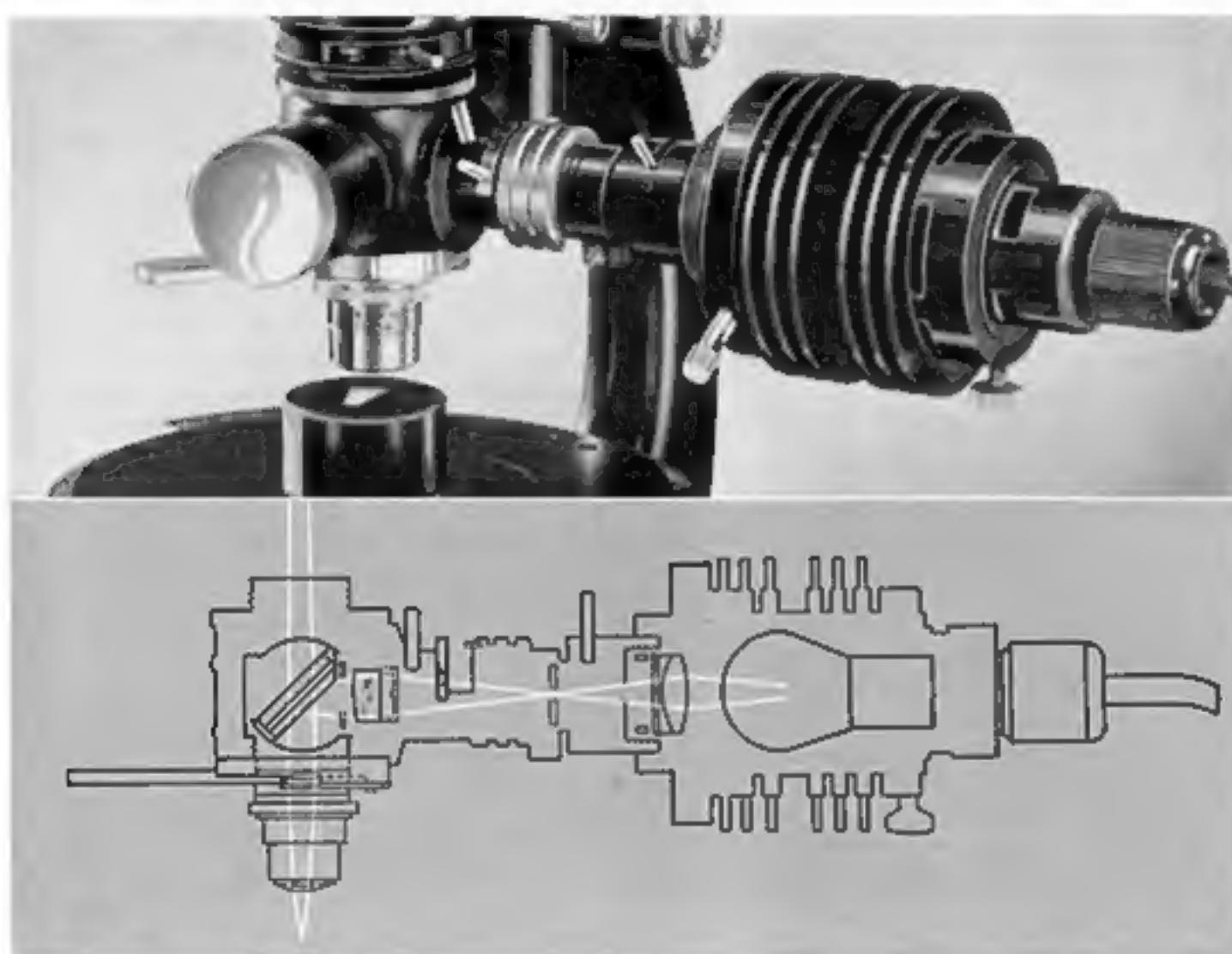
## ACCESSORIES FOR USE WITH REFLECTED LIGHT

## Vertical Illuminator

Designed for illuminating opaque specimens, the AO Spencer Vertical Illuminator No. 2531 with Illuminating Unit No. 2520 provides the intensity necessary for polarized light. It is conveniently attached to an AO Spencer Polarizing Microscope equipped with quick-change nosepiece by screwing it into the No. 463 Objective Centering Ring. In order to attach the illuminator to a microscope with revolving nosepiece, it is necessary to first remove the nosepiece from the microscope. Wrench No. 471 should be purchased for this purpose. Short-mount objectives, de-

scribed in an appropriately headed section, must be used with this illuminator.

Current AO Spencer Polarizing Microscopes have an intermediate body tube slide in addition to the rack-and-pinion adjustment, providing sufficient excursion for work with thick specimens even with the Vertical Illuminator in place. This feature eliminates the necessity of a focusable stage. Attachment of the illuminating unit directly to the Vertical Illuminator assures a perfectly aligned integral light source, which is not disturbed by refocusing the body tube.



*AO Spencer  
Vertical Illuminator  
in use.*

*Path of  
Light through  
Vertical Illuminator.*

## Reflectors

To direct the light through the objective, a semi-transparent plano-reflector and a first-surface mirror are mounted so that either is easily brought into operating position by sliding a horizontal bearing to one of two definite positions. Both reflectors are removable for cleaning.

Since the image-forming rays pass through the reflector as well as the objective, each reflector is made as precisely as the optical elements of the objective and individually inspected with an interferometer. Both surfaces are coated and are optically flat and parallel. One surface is coated with a high reflecting film to concentrate a maximum of light on the specimen; the other with a low reflecting film

to transmit the light which would otherwise be reflected out of the optical path. This unique feature increases the illumination and eliminates the double image of the field diaphragm.

## Diaphragms

For maximum contrast without unnecessary glare, a field diaphragm restricts the area of specimen illuminated to the field covered by the objective-eyepiece combination. An aperture diaphragm provides regulation of numerical aperture for best results with each objective.

**Nosepiece**

The nosepiece of the Vertical Illuminator permits rapid changing of the objectives which are mounted in adapters with handles. The nosepiece and adapter permit the short-mount objectives to be used to full advantage by positioning the rear focal plane of the objective as close as possible to the reflecting element of the Vertical Illuminator. Standard equipment supplied with the Vertical Illuminator No. 2531 includes one No. 2510 Objective Adapter. An extra Objective Adapter should be ordered for each additional short-mount objective to be used.

**Illuminating Unit**

Illuminating Unit No. 2520 has, as a light source, a concentrated-filament, low-voltage lamp of high intensity, and operates from 110 volt, 60 cycle AC by means of a variable transformer. Two centering screws, operating against a spring-loaded third point, permit convenient and rapid centering of the lamp. A built-in blue filter provides light of daylight quality, so important in the identification of opaque minerals and non-metallic inclusions in metal specimens.

**Filters**

For the use of filters to modify the color of light, a slot is provided in the Vertical Illuminator. A Polaroid filter is supplied for use as a polarizer. A green filter is also available, primarily for use with metal specimens without polarized light.



No. 2519 with Vertical Illuminator and Accessories in place.

**Vertical Illuminator Case**

Vertical Illuminator Case No. 2519 is both functional and attractive in design. Of wood construction, the case is attractively finished and features a felt-lined, fitted interior. Its sturdy compactness offers carrying convenience and storage protection.

Cat. No.	Description	Price
2531	Vertical Illuminator with reflector, mirror, field and aperture diaphragms, Polaroid filter, and one objective adapter, but without illuminating unit, transformer and case	
2520	Large Illuminating Unit with 6.5-volt, 2.75-ampere lamp, without transformer	
395	Variable Transformer for above	
2510	Objective Adapter (one is supplied as standard with No. 2531. For convenience, the purchase of an adapter for each additional objective to be used is recommended.)	
2513	Green Filter for Vertical Illuminator	
2519	Case for Vertical Illuminator and Accessories	
463	Objective Centering Ring for attaching Vertical Illuminator to Polarizing Microscopes which have quick-change nosepiece	
360	Lamp, 6.5-volt, 2.75-ampere for Large Illuminating Unit	MCP
471	Nosepiece Wrench	

**\*Achromatic Short-Mount, Strain-Free Objectives (For Reflected Light)**

{ \*The short-mount objectives listed below are for use with reflected light only. For work with transmitted light, see description of strain-free objectives on page F17.]



No. C1288

No. C1282

No. C1278

The objectives for use with Vertical Illuminator No. 2531 are achromatic, strain-free, short-mount, and corrected for use without a cover glass. Americated surfaces increase image contrast and light transmission.

Cat. No.	Equiv. Focus	Magnification	Numerical Aperture	Price
C1272	32mm	4X	.10	
C1278	16mm	10X	.25	
C1282	8mm	20X	.50	
C1288	4mm	40X	.85	
C1293	1.8mm	95X (oil)	1.25	



# POLARIZING MICROSCOPES

## MISCELLANEOUS ACCESSORIES

Frequently it is desirable to use with the polarizing microscopes various other microscope accessories originally designed for regular laboratory microscopes. While some of these accessories are not used under conditions of polarized light, they often give invaluable aid in observing, detecting,

or analyzing certain specimens. Only the more popular of these items will be listed here. Information on other items will be given upon request. When ordering these accessories, please be sure to specify microscope model and serial number.

### Adjustable Laboratory Illuminator No. 370B

The AO Adjustable Laboratory Illuminator No. 370B is designed to meet a wide range of laboratory needs. It is equipped with a two-element condensing system, a graduated iris diaphragm which controls the amount of light reaching the specimen, a convenient circular filter holder, an easily removed bayonet base lamp in focusing mount, and one Corning Daylite Glass Filter. This illuminator, mounted on a heavy ring base, has a 6½" elevating pillar.



No. 370B

Cat. No.	Description	Price
370B	Illuminator, complete as described, with simple filter holder, iris diaphragm, Corning Daylite Glass, one 100 watt, 120 volt lamp, and 3 foot cord with switch	
554	Multiple Filter and Water Cell Holder to fit No. 370B Illuminator, of special use to photomicrographers and microscopists requiring illumination control. Accommodates both circular and square filters	
553	Water Cell	

### Advanced Laboratory Illuminator No. 735B

The AO Spencer No. 735B Illuminator, designed for advanced laboratory work, is an efficient accessory to the microscope. It features a focusable two-element condensing system, screw-type tilting adjustment, and convenient external adjustments and controls. Standard equipment includes a simple filter holder and a large-size iris diaphragm which attach directly to the lens barrel, as well as one Corning Daylite Glass Filter.



No. 735B

Cat. No.	Description	Price
735B	AO Spencer Microscope Illuminator, with simple filter holder, iris diaphragm, Corning Daylite Glass, one 100 watt, 120 volt lamp, and 3 foot cord with switch	
738	Multiple Filter Holder, to fit No. 735B Illuminator	

### Neutral Density Filters

Three accessory neutral density filters (square) of 5%, 25%, and 50% transmission are available for microscope illumination intensity control.



No. 662B with No. 656.  
(Shown with microscope and illuminator in position.)

Cat. No.	Description	Price
743	Square Neutral Density Filter, 3" x 3", transmission 50%	
744	Neutral Density Filter, 3" x 3", transmission 25%	
745	Neutral Density Filter, 3" x 3", transmission 5%	

### Photomicrographic Cameras

AO Spencer Photomicrographic Cameras are well-designed, yet moderately priced. Illustrated is model No. 662B for 4" x 5" plates. Information on models for 35mm, cut film, or other plate sizes is available upon request. If the camera is to be used with Microscopes Nos. 37, 39, 40, and 41, specify the No. 655 Large Diameter Light-Tight Adapter when ordering. If the camera is to be used with Microscopes Nos. P42, P43, and 44, specify Standard Diameter Light-Tight Adapter No. 656.

Cat. No.	Description	Price
662B	Base and arm, focusing telescope and Universal Shutter, 4" x 5" camera back, light-tight adapter No. 656 or No. 655 (see preceding paragraph), two double plate holders	

**Dark Field Accessories**

The No. 344 Dark Field Condenser includes a centering mount and objective aperture stop. The No. 329 Dark Field Illuminator with built-in light source includes a centering mount, one lamp, and objective stop (transformer or resistance extra). Either condenser will fit the rack-and-pinion fork-type substage of AO Spencer Polarizing Microscopes. Specify microscope serial number when ordering.

Cat. No.	Description	Price
344	Dark Field Condenser in case	
329	Dark Field Illuminator with built-in light source, without transformer or resistance, in case	
391	Fixed Transformer, 110 volt	
395	Variable Transformer, 110-115 volt to 6.5 volt	
337	110 volt Resistance, D.C.	



No. 500

**Microprojection Prism**

The No. 346 Microprojection Prism is a useful teaching accessory. It fits standard diameter eyepiece tubes without an adapter. Large diameter eyepiece tubes on Polarizing Microscopes Nos. 37, 39, 40, and 41 require the use of the No. 551 Universal Adapter.

Cat. No.	Description	Price
346	Prism, 45-90° type, hinged to clamp which fits standard diameter eyepiece tubes, in case	

**Demonstration Eyepieces**

AO Spencer Demonstration Eyepieces Nos. 432 and 434 permit two persons to observe the same microscopic field at the same time. The No. 551 Universal Adapter is used with Polarizing Microscopes Nos. 37, 39, 40, and 41.

Cat. No.	Description	Price
432	Demonstration Eyepiece with 7.5X Eyepieces, in case	
434	Demonstration Eyepiece with 10X Eyepieces, in case	



No. 344

**Phase Condenser**

No. 1000135 Single Unit Phase Condenser with No. 328-861 Fork Mount Adapter may be used on AO Spencer Polarizing Microscopes. Information on annular diaphragms and phase objectives will gladly be furnished upon request. Specify microscope serial number when ordering.

Cat. No.	Description	Price
1000135	Single Unit Phase Condenser including No. 328-861 Fork Mount Adapter for AO Spencer Polarizing Microscopes; with centering telescope, without diaphragms, in case	

**Camera Lucida**

The No. 500 AO Spencer Camera Lucida may be used on AO Spencer Polarizing Microscopes Nos. P42, P43, and 44 without an adapter. Microscopes Nos. 37, 39, 40, and 41 require the No. 551 Universal Adapter.

Cat. No.	Description	Price
500	Camera Lucida in case	



No. 432

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